Embedded Simulation for the Networked Unmanned Ground Air Systems Experiment

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Abstract

In support of the Networked Unmanned Ground Air System (NUGAS) Experiment, and in support of evolving unmanned vehicle capabilities in general, the TARDEC Embedded Simulation System (ESS) has undergone significant modifications. These changes include updated hardware to support the latest off-the-shelf graphics products, a re-architecting of the ESS system software to support unmanned vehicle mission planning and crewstation independent modeless operation, the addition of Unmanned Air Vehicle (UAV) control, and database and Semi-Automated Forces (SAF) support specific for NUGAS. As the new ESS is still a work in progress, planned capabilities will be discussed as well as the differences from earlier versions of the ESS used in support of the Unmanned Combat Demonstration (UCD) and Crew integration and Automation Testbed (CAT) phase one activities.

Agenda

- Intelligent Systems Embedded Simulation
- CAT/RF Phase I and Phase II ESS
  - Software
  - Hardware
- CAT/RF Phase II Objective System

Intelligent Systems
Embedded Simulation System (ESS)

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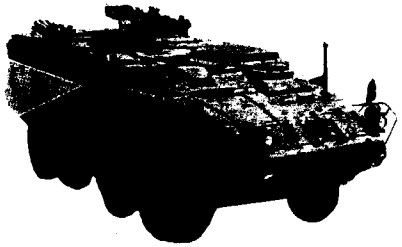
Crew Stations

Vehicle and crew interaction data

Embedded Simulation System

FCS Class Vehicle



MISSION APPLICATIONS

Embedded Training
Mission Rehearsal
Mission Planning

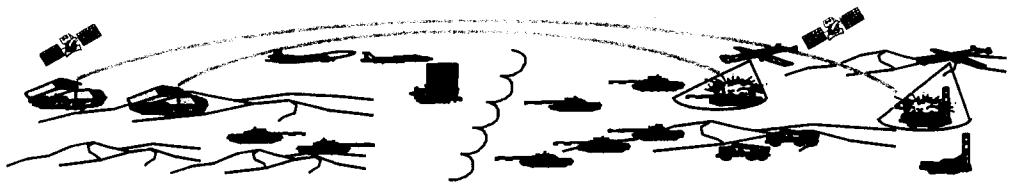
SIMULATION BASED ACQUISITION

Simulated Turret
Virtual Lethality
Virtual Sensors
Simulated ATR
Simulated ATT
Simulated C2

VEHICLE SIMULATIONS

Mobility
Survivability
Virtual OPFOR
Virtual Friendlies

Virtual Battlefield



OPERATIONAL APPLICATIONS

Battlefield Visualization
Terrain Registration
Virtual Sensor Coverage
Virtual Lethality Coverage

CAT/RF Phase II ESS Improvements

- Software architecture decoupled from vehicle states and modes allowing for more robust on-demand request servicing.
- Chassis form factor (1U for phase I vs. 2U for phase II) allows for growth in form factor of graphics cards. Overall phase II system volume remains unchanged due to reduced mother-board size (dual vs. single hyper-threaded processors respectively).
- Reduced heat output through more efficient forced air cooling.
- Easier access to individual video channels through new frame design.

CAT/RF Phase II ESS Improvements (Cont)

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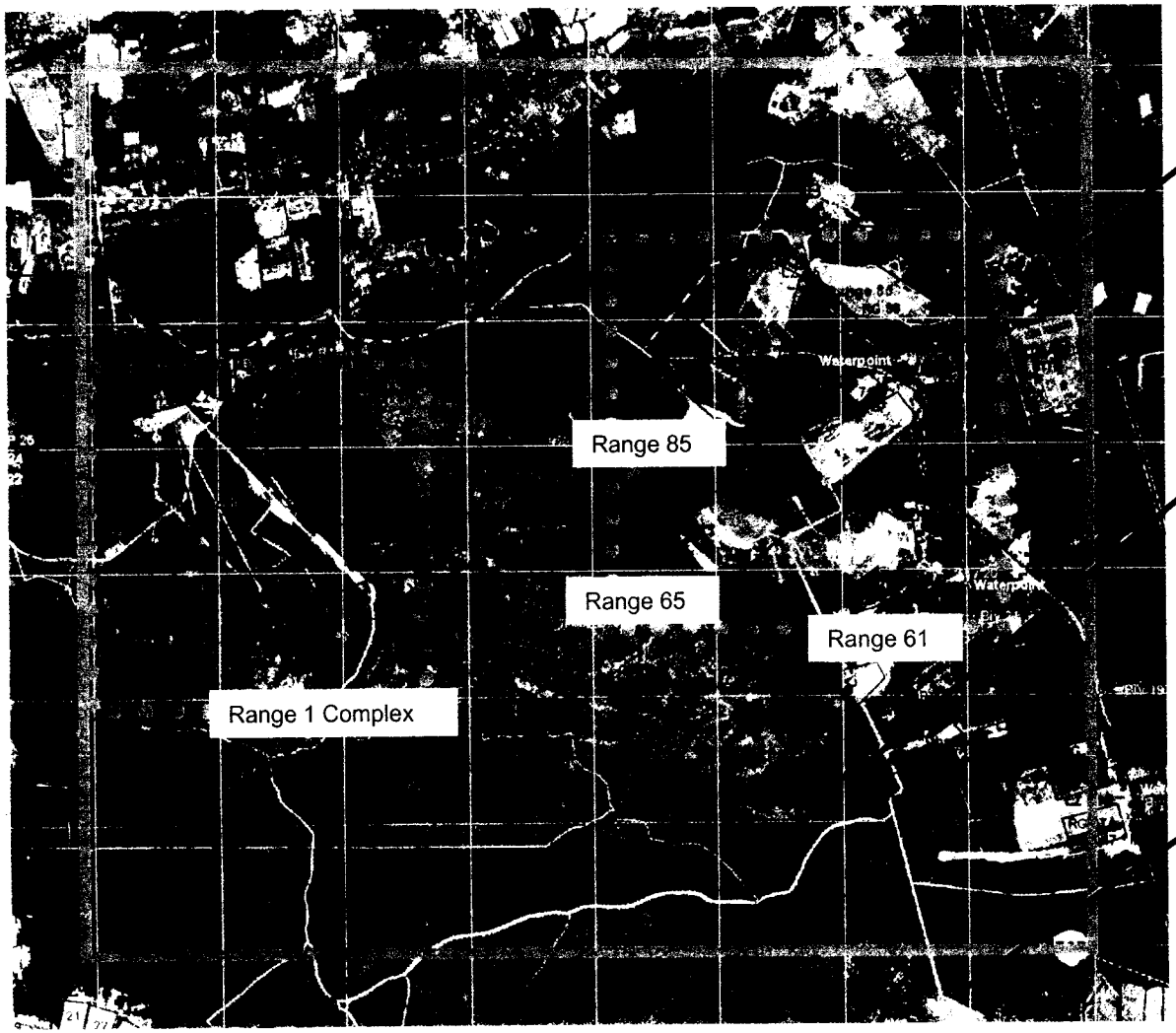
- Supports Windows based Image Generators.
- More powerful Image generation capabilities in same amount of overall volume. Allows for rendering of higher resolution terrain databases.

• Phase I	• Phase II
– 136 million vertices/sec	– 356 million vertices/sec
– 2.4 billion texels/sec	– 3.8 billion texels/sec
– 1.2 billion pixels/sec	– 1.9 billion pixels/sec
– 10.4 GB memory bandwidth	– 30.4 GB memory bandwidth

- Note: CAT/RF phase II ESS processes run on Linux while IGs run on Windows. This was a change forced by IG vendor migration to Windows OS. ESS processes may eventually be ported to Windows as support for Linux based IGs continues to diminish.

Terrain Database



1m resolution w/canopy and feature data

10m resolution w/ canopy

10m resolution wo/ canopy

CAT/RF Phase II ESS Improvements (Cont)

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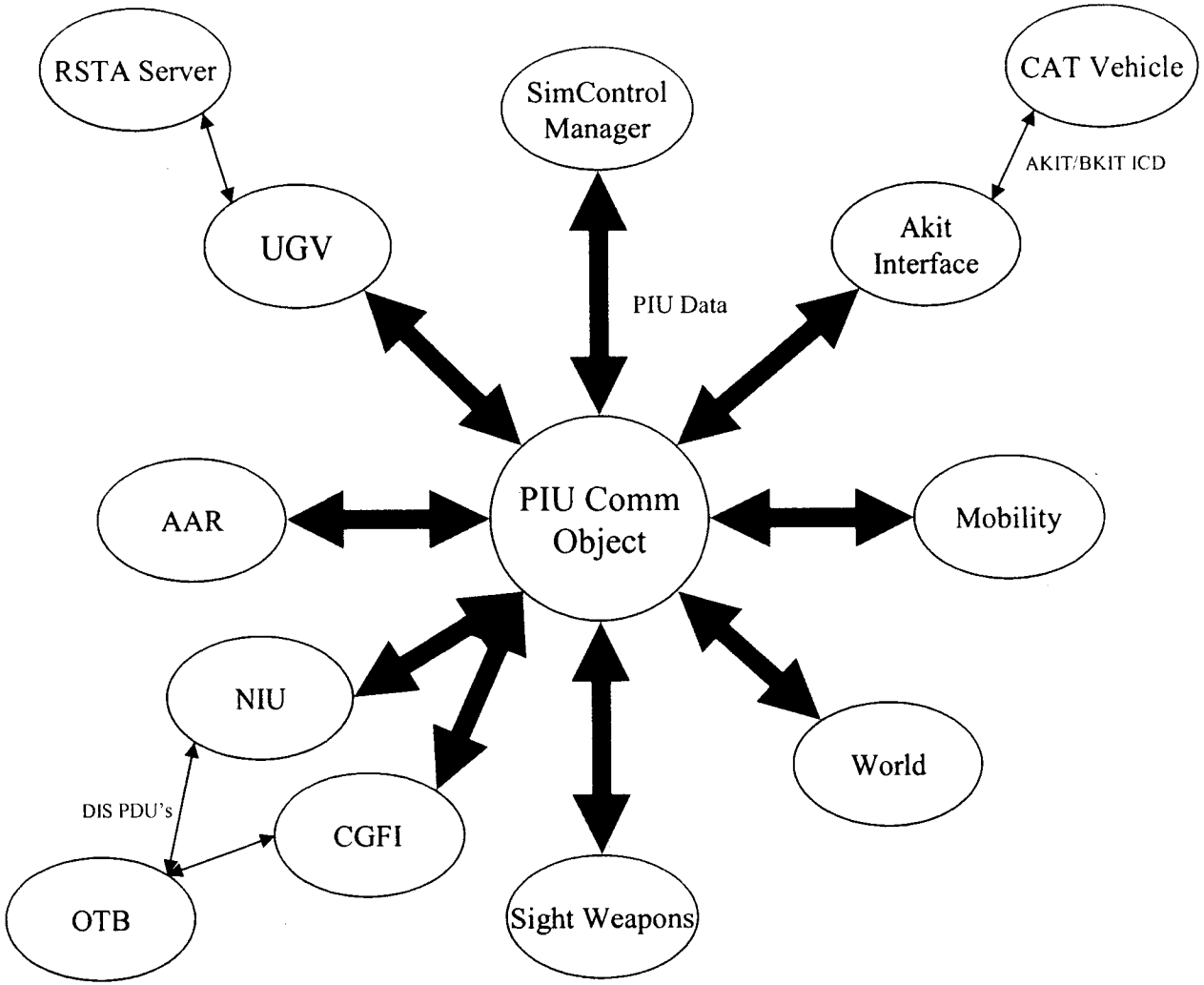
- Added functionality for NUGAS to include:
  - Modeling and control of class I fixed wing UAVs.
  - Munitions fly out server
  - Scenario description files
  - ESS start-up GUI for vehicle payload selection
  - Situational awareness sensor
  - Convoy mode operations

CAT/RF Phase II ESS Improvements (Cont)

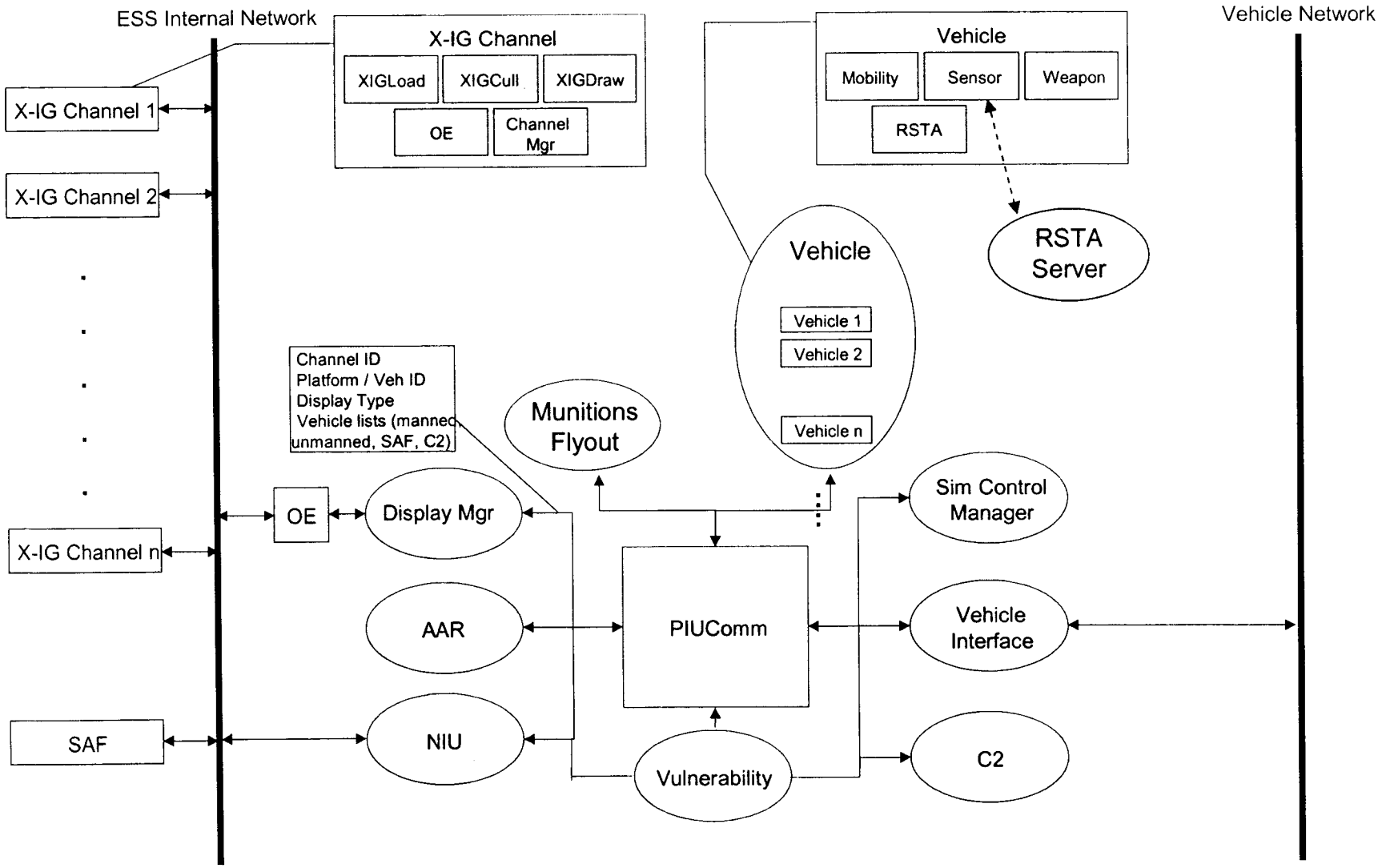
TARDEC

- Objective (final) CAT/RF ESS to also include:
  - Class II helo UAV modeling and control
  - SUGV modeling and control
  - UGV Autonomous Navigation (OTB controlled)
  - Survivability – signature management, reactive armor, counter-measures models
  - Mission Rehearsal and Embedded Training capability through in-vehicle scenario creation and intelligent tutoring
  - Mine detection
  - Dynamic dismounted infantry simulation
  - Wingman simulation
  - Power and Energy server

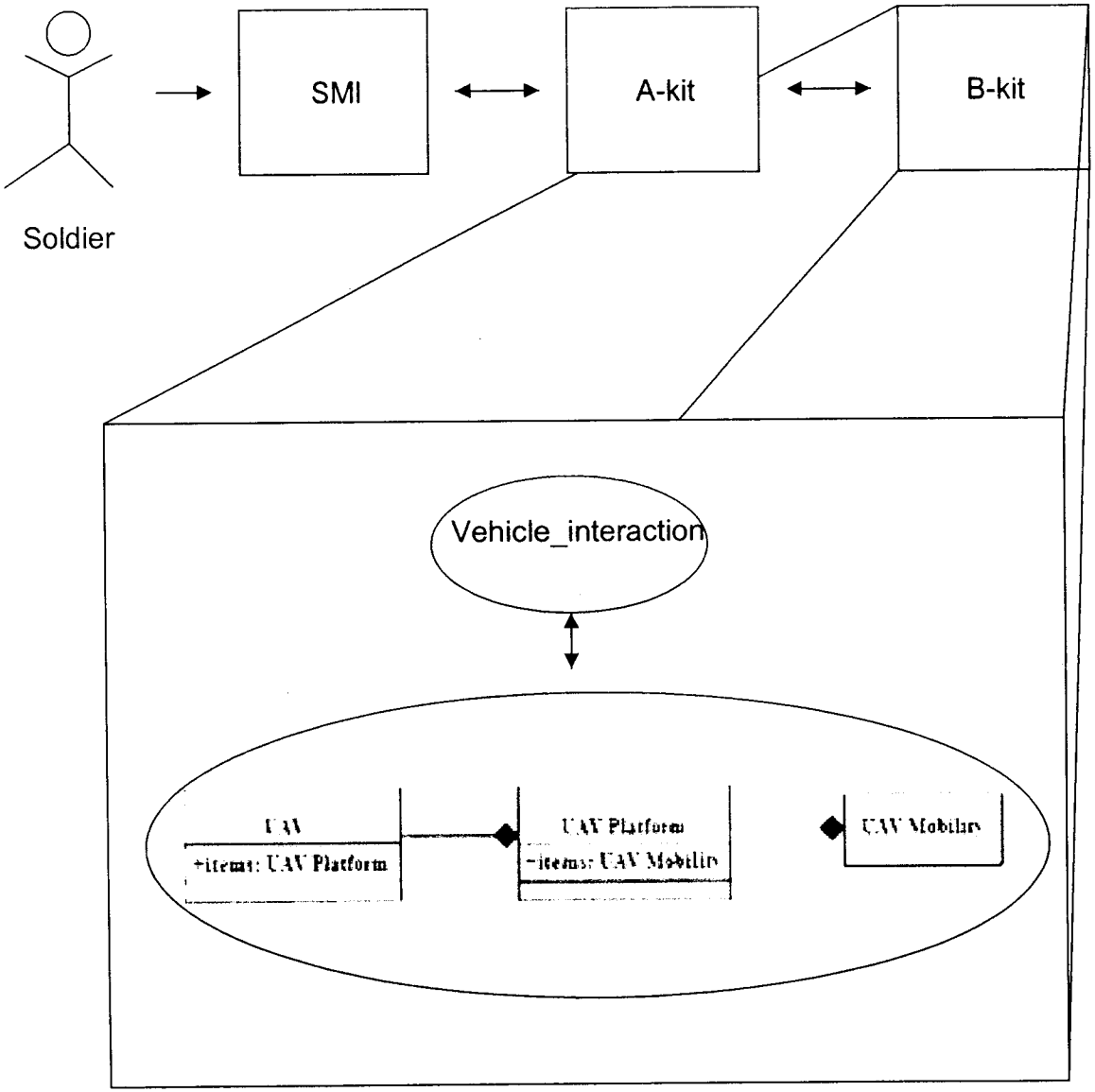
CAT/RF Phase I Software Architecture



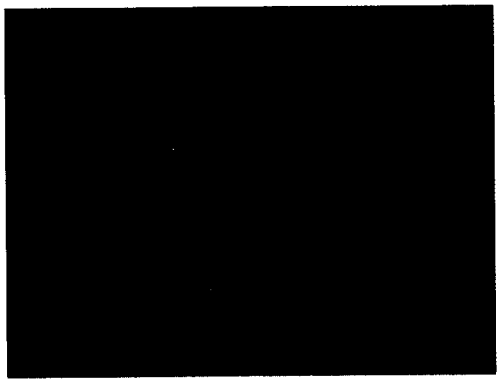
CAT/RF Phase II Software Architecture

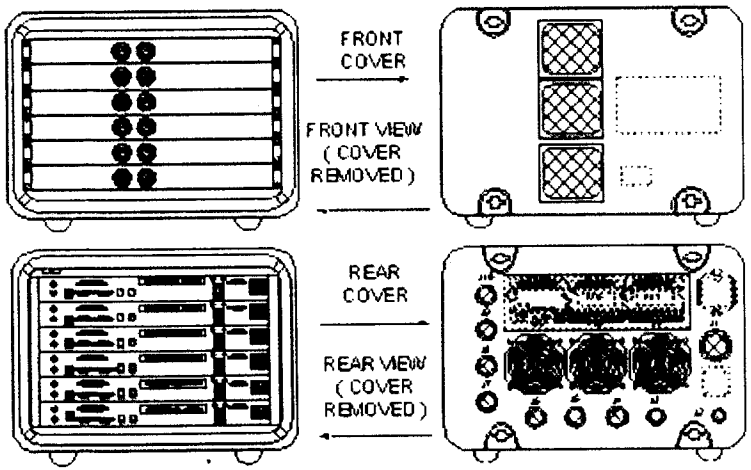


UAV High Level Design



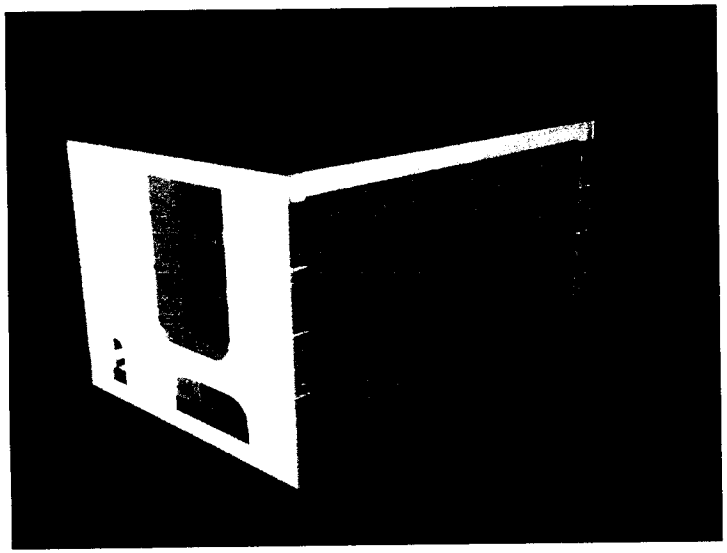
CAT/RF Phase I Hardware Architecture

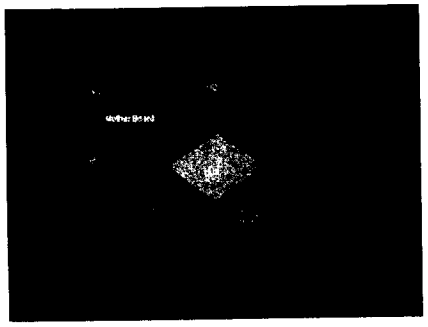


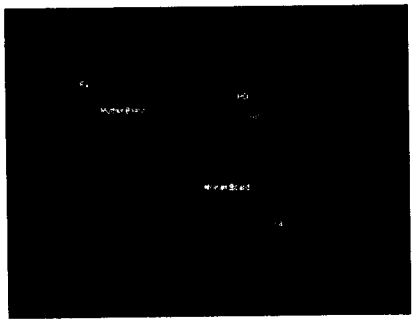


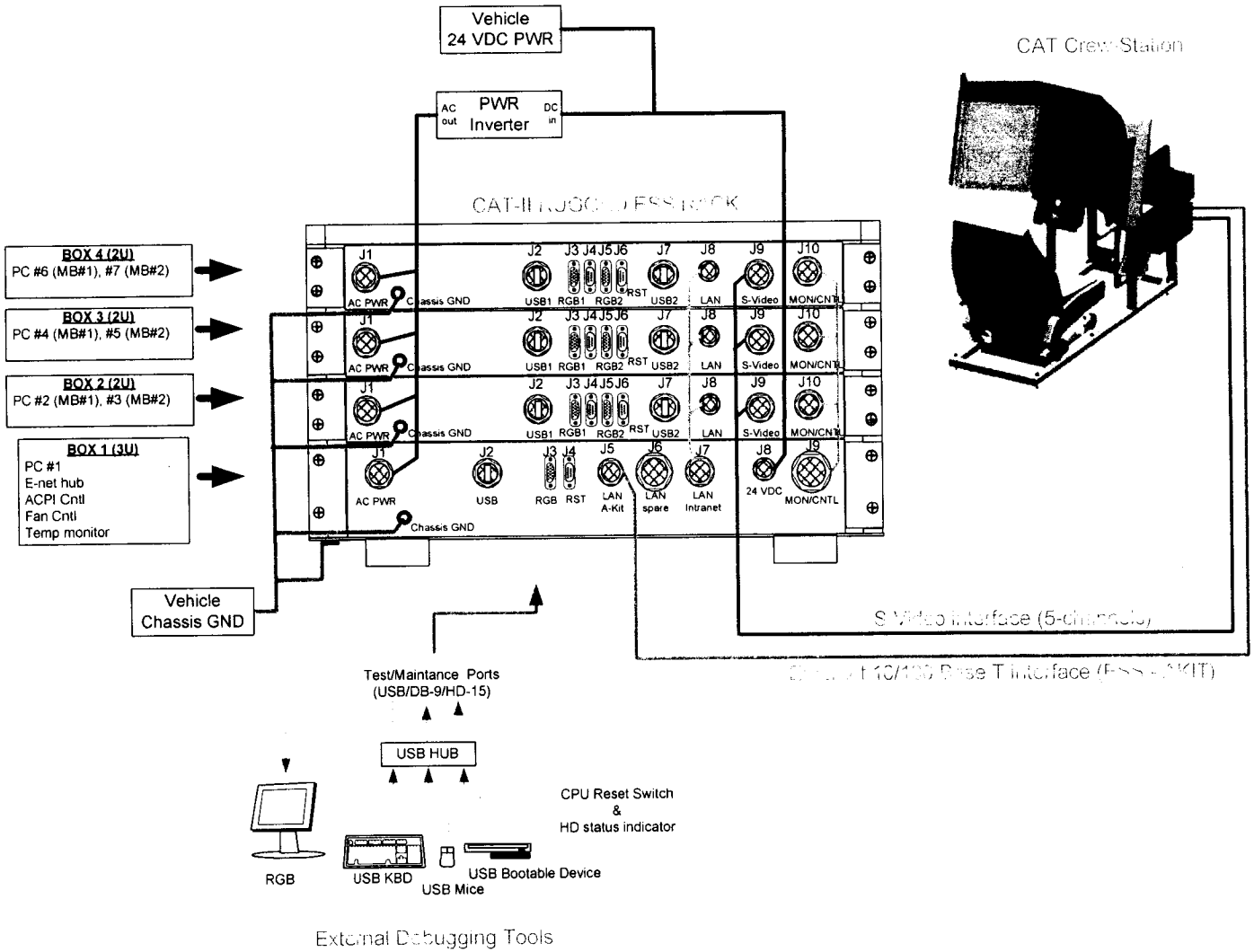
- ESS Used Commercial-off-the-shelf (COTS) hardware.
- Video channels packed in a shock mounted transit case.
- Each channel is a RacksaverTM 1U box containing a TyanTM dual processor (1.6 GHz) motherboard and a TI 4600 graphics card
- It also contains a National Instruments Field PointTM unit that can shut down the ESS if temperatures inside any of the boxes reach a programmable threshold level.
- Overall, the hardware performed well. Overall dimensions at 24"w x 29"d x 17"h.
- Heat dissipation through transit case mounted fans.

CAT/RF Phase II Hardware Architecture







- Custom designed rack mounted on shock isolators
- Individual boxes on slide mount trays
- Four ruggedized boxes
  - Three boxes, each contain (2) ESS Computers
  - One box, contains (1) Computer with Temp Module and E-net HUB
- Independent boxes provide ease of installation and service
- Over all dimension: 31"L x 24"D x 21"H
- Intel Pentium 4 Processor 3.2 GHz with Hyper-Threading Technology
- GeForce FX 5950 Ultra GPU
- Heat dissipation will be via forced air and

ESS Hardware
System Interconnect Diagram